

# The changes of co-possession of plant species between communities with altitudes on northern slope of Changbai Mountain

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**Abstract:** Twenty plots were investigated on northern slope of Changbai Mountain at an altitude interval of 100 m (from 700 to 2 600 m). The species co-possession between plant communities at different altitudes was analyzed by Jaccard index. The analytical results showed that the co-possession calculated according to species in different layers or all species between adjacent communities was higher than that between disjunct communities. The co-possession between adjacent communities calculated by species in different layers had comparability and dissimilarity. If the two adjacent communities belong to different types of vegetation, then their co-possession was lower. The peak values and valley values of species co-possession between communities along elevation gradient just matched vegetation gradient patterns, and species subrogation of shrubs had more obvious rule on northern slope of Changbai Mountain. Co-possession between communities with same altitude difference were much similar, and it decreased as the increase of elevation difference, which showed that species compositions in different layers of the communities were highly related.

**Key words:** Changbai Mountain; Co-possession; Plant community; Altitude gradient

**CLC number:** S718.54

**Document code:** A

**Article ID:** 1007-662X(2001)02-0089-04

## Introduction

Co-possession between plant communities along altitude gradient reflects the rule of species substitution along environmental gradient and the interrelation between communities, and it indicates the comparability of communities and the coexistence of plant species. There exists obvious environmental gradient on the northern slope of Changbai Mountain, and species compositions are variational along altitude gradient (Wang *et al.* 1980). The seriate or discontinuous distribution of different species along altitude gradient can reflect not only the rule of environment varying along altitude, but also the biological and ecological characteristics and adaptabilities of the species. In this study, based on analysis of co-possession between different communities along altitude gradient, the variation of forest communities' biodiversity and comparability of communities along altitude gradient were explored.

## Study area and methods

### Study area

The study area was distributed between the altitudes of

700 m and 1 900 m on the northern slope of Changbai Mountain, and its horizontal distance was 40 km. At the altitude of 700 m, the annual temperature averages 2.8 °C and it belongs to the typical temperate zone. At the altitude of 1 900 m, the average annual temperature is -3.3 °C and it is the sub-alpine climate (Chi *et al.* 1981; Yang 1981). The precipitation is increased with altitude rising, and at the altitudes of 700 m and 1 900 m, the precipitation is 680 mm and 1 038 mm respectively (Chi *et al.* 1981; Yang 1981; Zhang *et al.* 1984). Along with the variety of altitude, there exist different vegetation types: broad-leaved Korean pine forest (altitude lower than 1 100 m), dark coniferous forest (1 100-1 800 m), and sub-alpine *Betula ermanii* forest (1 800-2 000 m) (Wang *et al.* 1980; Zhao 1980; Li *et al.* 1994; Hao *et al.* 2000).

### Sample

The sample was set by gradient pattern. Thirteen 32-m×32-m plots from altitude of 700 m to 1 900 m (Deng *et al.* 2000) and seven 16-m×16-m plots from altitude of 2 000 m to 2 600 m were investigated at an altitude interval of 100 m.

### Investigation

Basic status such as altitude, slope degree, and coverage of the plots was investigated, and a sketch of each plot was drawn. In each small plot, for herbs and shrubs, the species, abundance, coverage, average and the height were investigated, and for trees, the species, diameter and height were investigate. All the field research was carried out in the summer of 1999 (Deng *et al.* 2000).

**Foundation item:** This paper was supported by the Chinese Academy of Science (a grant KZCX2-406), National Natural Science Foundation of China (NSFC39970123), and Changbai Mountain Open Research Station.

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**Received date:** 2001-02-10

**Responsible editor:** Song Funan

### Co-possession of communities

Co-possession of communities was defined as percentage of common species and total species in two communities. In this research, it was expressed as Jaccard index (Mueller-Dombois 1974; Magurran 1988). For example, if  $a$  was species number in community A,  $b$  was species number in community B, and  $c$  was common species number of these two communities, then co-possession ( $CP$ ) between community A and B was expressed as:

$$CP = \frac{c}{a + b - c} \times 100 \% \quad [1]$$

In the formula, numerical value of  $CP$  was between 0 and 1.

**Table 1. Co-possession between communities according to all plant species %**

Community	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2	22.1																		
3	23.8	46.8																	
4	32.3	40.4	47.3																
5	14.1	39.4	38.6	36.8															
6	9.9	42.4	40	31.9	55.6														
7	11.6	34.4	36.4	33.3	53.1	66													
8	13.8	35.4	34.1	37.1	52.1	48.5	50.7												
9	18.1	34.2	34.3	38.2	42.9	36.4	41.2	60.2											
10	9.6	26	22.2	22.5	32.1	31	31	53.6	62.3										
11	9.2	25.7	22.1	22.4	34.6	26.9	25.3	43.6	47.2	52.9									
12	8.9	21.4	23.7	21.6	29.9	28.7	30.4	39.8	45.2	45.9	39								
13	3.1	14.3	15.7	9.9	20.3	25.4	23.4	22.7	18.1	20	23.3	40.3							
14	0.7	2.7	4.2	0.9	4.5	3.8	3.8	5.5	5.5	6	6.8	11.4	17.5						
15	0	0.9	0	0.9	2.4	1.3	1.3	2.3	1.9	2.5	3.5	5.7	9.7	50					
16	0	1	0	1	0	0	0	0	1	1.3	1.2	3.6	10.7	40.4	57.9				
17	0	0	0	0	0	0	0	0	1	0	0	2.4	7.1	36.2	56.8	62.5			
18	0	0	0	0	0	0	0	0	0	0	0	2.5	5.6	32.6	41	48.5	51.6		
19	0	0	0	0	0	0	0	0	1	0	0	2.5	5.4	37	50	45.7	58.1	58.6	
20	0	0	0	0	0	0	0	0	1.1	0	0	1.3	2	19.1	25	22.2	31.3	30	51.9

**Annotation:** Communities code (1, 2, 3, ..., 20) corresponding to different altitudes (700 m, 800 m, 900 m, ..., 2 600 m).

The co-possession between adjacent communities, calculated according to species in different layers (Fig. 1), have rules of comparability and dissimilarity. According to trees in main layer, the maximum co-possession was between altitude 1 500 m and 1 600 m, and it was 100%. The co-possession based on all trees had the similar varying trend as that referring to main layer trees, but the maximum was between 1 600 m and 1 700 m. It meant that trees in succession layer and regeneration layer between 1 600 m and 1 700 m were more similar than that between 1 500 m and 1 600 m. Because there are few tree species such as *Betula ermanii* distributed at altitude of 2 200 m, the altitude range of all trees was wider than that of trees in main layer. In the coniferous forests, from 1 100 m to 1 700 m, the co-possession by main layer trees and all trees were 66% and 69% respectively, which were relatively high,

### Results

The corresponding half-matrix tables of co-possession were calculated according to trees in main layer, all trees, shrubs, herbs, and all species in different communities along altitude gradient respectively. Table 1 was one of the half-matrix, and it was calculated according to all species. Based on Table 1, co-possession between adjacent communities was obviously higher than that between disjunct communities. The adjacent communities with lower co-possession such as community 1 (700 m) and 2 (800 m), community 4 (1 000 m) and 5 (1 100 m), and community 13 (1 900 m) and 14 (2 000 m) were ecotones between different vegetations exactly. So, co-possession reflected comparability between communities clearly.

while the altitude is below 1 100 m, the co-possession were 30% and 40% respectively, which implied that there existed more variation of tree species in broadleaved Korean pine forest.

The valley (lower) values of species co-possession between adjacent communities appeared between altitudes of 700 m and 800 m, 1 000 m and 1 100 m, 1 700 m and 1 800 m, 1 900 m and 2 000 m, 2 300 m and 2 400 m, and 2 500 m and 2 600 m. At these altitudes they were ecotones between different vegetation types exactly. It showed that species subrogation of shrubs had obvious rule on northern slope of Changbai Mountain. As the proportion of herbs to all plant species is big, the co-possession based on herbs had the same trend as that based on all species, and their values were near.

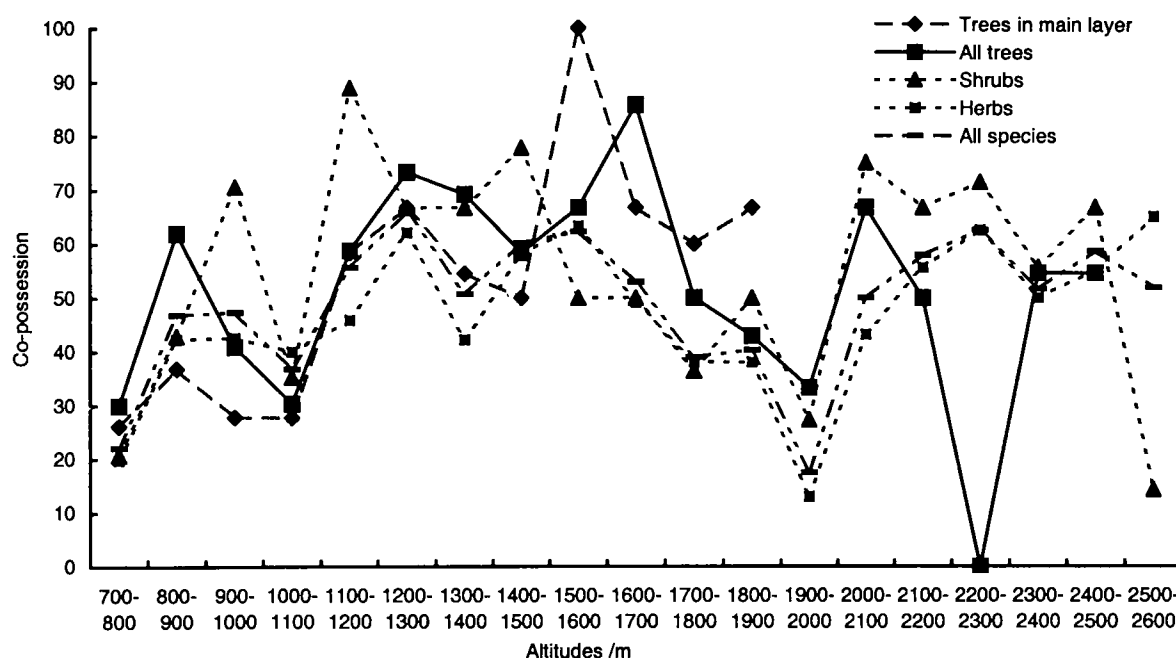


Fig.1 Co-possession between adjacent communities according to different layers and all species

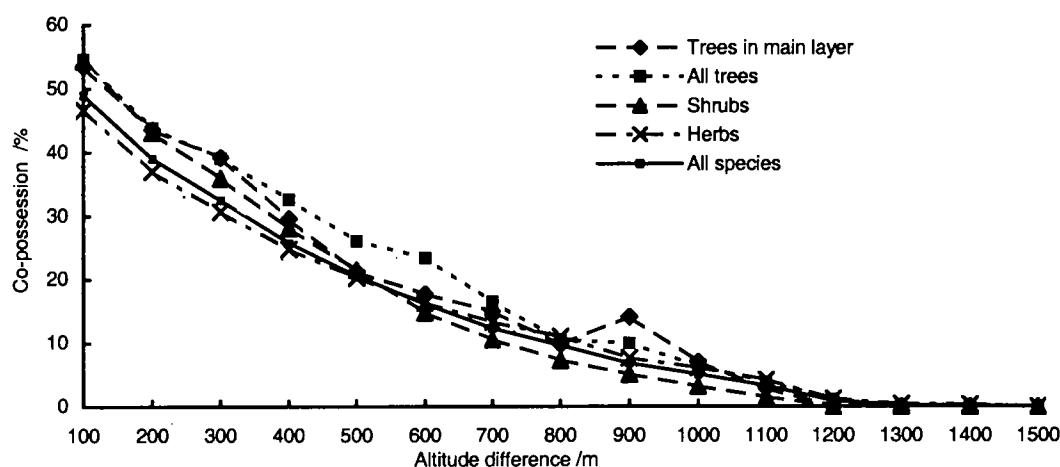


Fig. 2 Variation of co-possession according to different layers along with altitude difference varying

Co-possession between disjunct communities decreased while altitude difference increasing, and it reflected the close relationship between average co-possession (between disjunct communities) and altitude difference (Figure 2). As altitude differences were the same as each other, the values of co-possession calculated according to trees, shrubs, herbs, and all species were very similar and all decreased to similar extent (from 50% with altitude difference of 100 m to 0 with altitude difference of 1200 m) while altitude difference increasing. The similar varying tendency of co-possession by species in different layers showed that there existed obvious relativity in species compose of different layers.

## Conclusions

Co-possession calculated according to all trees had the similar varying trend as that based on main layer trees, but the maximum was between 1600 m and 1700 m. It means that trees in succession layer and regeneration layer between 1600 m and 1700 m were much similar than that between 1500 m and 1600 m. Co-possession calculated by trees in main layer and all trees in the coniferous forests from 1100 m to 1700 m were higher than those below 1100 m, which implied that there existed more variation of tree species in broadleaved Korean pine forest. Species subrogation of shrubs had obvious rule on northern slope

of Changbai Mountain, and at the altitudes with valley values of co-possession they were ecotones between different vegetation types exactly. As the proportion of herbs to all plant species is big, the co-possession based on herbs had the same trend as that based on all species, and their values were near. The co-possession between disjunct communities decreased while altitude difference increasing, which reflected that there existed a close relationship between average co-possession (between disjunct communities) and altitude difference. The co-possession calculated according to species in different layers had similar varying tendency. This indicated that there existed obvious relativity in species compose of different layers.

According to altitude range of species distribution, 2/3 of total species distributing on northern slope of Changbai Mountain had a wide altitude range, and other species distributed in special habitat with certain altitude. About 27% of trees, 36% of shrubs, and 32% of herbs have distributions only in a certain range of altitude. Although the results were highly related to sampling methods, they reflected the species' characteristic of narrow distributing range to certain extent. To protect biodiversity, protection of these species with narrow distributing range should be considered especially.

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